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ABSTRACT

This paper presents a study of the relationship between compensation and conservation in 80 children, ages 5-6. Findings are compared to those of an earlier experiment which was designed to determine whether or not prior knowledge of the compensation rule increases kindergarten children's susceptibility to conservation training experiences. It is suggested that the key finding of the first experiment (a correlation between pretraining performance on a compensation test and posttraining conservation performance) could have been an artifact of a spurious correlation between these two variables and an uncontrolled third variable (pretraining conservation performance). The previously reported experiment was replicated with the third variable controlled. Results of the present experiment provide no support for the hypothesis that prior knowledge of compensation does not predict relative trainability. (CS)

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DOES PRIOR KNOWLEDGE OF THE COMPENSATION RULE INCREASE SUSCEPTIBILITY TO CONSERVATION TRAINING?

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A previously reported experiment appeared to demonstrate that prior knowledge of the compensation rule is positively correlated with susceptibility to conservation training. It is shown that the key finding of this experiment, a correlation between pretraining performance on a compensation test and posttraining conservation performance, conceivably could have been an artifact of a spurious correlation between these two variables and an uncontrolled third variable (pretraining conservation performance). The previously reported experiment was replicated with the third variable controlled. This time no support was found for the hypothesis that pretraining compensation rule knowledge is related to trainability.

DOES PRIOR KNOWLEDGE OF THE COMPENSATION RULE INCREASE SUSCEPTIBILITY TO CONSERVATION TRAINING?

In an earlier number of this journal, Curcio, Kattef, Levine, and Robbins (1972) reported an experiment designed to determine whether or not prior knowledge of the compensation rule increases children's susceptibility to conservation training experiences. Curcio et al.'s subjects were pretested for both the compensation rule (the height of a quantity transferred from one container to another must increase or decrease accordingly as the new container is narrower or wider than the previous one) and discontinuous quantity conservation. Those subjects who failed at least two of four conservation pretests were divided into experimental and control groups. The subjects in the experimental group subsequently received training, while the subjects in the control group did not. The subjects in both groups were posttested for three versions of quantity conservation (discontinuous, liquid, solid) immediately after training and one week later. The subjects in the experimental group were divided into "compensators" (passed 3/4 or 4/4 compensation pretests) and "noncompensators" (passed 0/4, 1/4, or 2/4 compensation pretests). When the posttest performances of these two groups were compared, it was observed that compensators performed better. This finding led Curcio et al. to conclude that "children who recognize a compensatory relationship between height-width dimensions are more susceptible to conservation training than children who do not recognize this relationship (p. 263)."

The preceding conclusion is substantively important because, at present, there is disagreement in the literature about the exact relationship between compensation

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and conservation. In Piagetian theory, compensation is viewed as an essential precondition for conservation (cf. Brainerd & Allen, 1971; Halford, 1970; Wallach, 1969). This entails an intimate functional connection between the two concepts and it also entails a developmental sequence such that compensation emerges before conservation (Curcio et al., 1972). However, no clear relationship between conservation and compensation was observed in studies reported by Gelman and Weinberg (1972) and Larsen and Flavell (1970).

Unfortunately, the conclusion that "compensators" are more susceptible to conservation training than "noncompensators" does not necessarily follow from the data Curcio et al. reported. What their data actually establish is that there apparently is a positive correlation between pretest compensation performance and posttest conservation performance. It is quite possible that this correlation does indeed result from a greater training susceptibility among subjects who already grasp compensation. However, it also is possible that all or part of this correlation results from a spurious correlation of both variables with a third variable: pretest conservation performance. Pretest conservation performance is known to correlate with both variables (cf. Brainerd, 1972b, 1974a; Strauss, 1972). The potential effects of these two spurious correlations were not controlled in the Curcio et al. experiment. The "nonconservers" included in the training condition could give as many as 2/4 correct responses on the conservation pretests. If these correct responses happened to be localized primarily within the "compensators," then the observed correlation between pretest compensation is guaranteed for reasons that have nothing to do with the greater trainability of compensators.

To eliminate this source of ambiguity, the present experiment was conducted. Generally speaking, the experiment was a straightforward replication

of Curcio et al. However, there were two major departures from Curcio et al.'s original design: (a) a different training procedure was employed and (b) a partial correlational analysis of the three dependent variables was conducted. Concerning a, the training procedure was a simple feedback technique. This procedure has several advantages over the one employed by Curcio et al.: it has been extensively studied with several concrete-operational concepts (cf. Brainerd, 1974a, for a review); it is far simpler to administer; it allows the experimental and control groups to be more precisely equated. Concerning b, the partial correlations between pretest compensation/pretest conservation, pretest conservation/posttest conservation, and pretest compensation/posttest conservation were all computed. The latter correlation, in which the effects of pretest conservation have been partialed out, is the appropriate estimate of the relationship between compensation knowledge and trainability.

Method

Subjects

A total of 118 white middle-class kindergarten children were pretested. The final sample consisted of 80 children (40 boys and 40 girls) who ranged in age from 5 years, 4 months to 6 years, 2 months. The mean age of the final sample was 5 years, 9 months. The experimenter who pretested, trained, and posttested the children was a white 24-year-old female.

Materials

The materials for assessing and training discontinuous quantity conservation were: a large bowl containing bird seed; two 20 X 8.75-cm glasses;

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one 20 X 6.25-cm glass; one 20 X 3.00-cm glass; one 20 X 11.25-cm glass;one 20 X 13.75-cm glass. The materials for assessing compensation were the same as for discontinuous quantity conservation. The materials for assessing liquid quantity conservation were a large bowl containing red colored water and the glasses just mentioned. The materials for assessing solid quantity conservation were four pairs of identical clay balls approximately 5-cm in diameter. One pair was red, one pair was blue, one pair was green, and one pair was brown.

Pretests

The subjects were pretested for both conservation of discontinuous quantity and compensation. The experimenter and the subject sat across from each other at a large rectangular table. Half the subjects were pretested for compensation first and half were pretested for conservation first. Each pretest consisted of four items. For any given subject, the order in which the four items were presented was random. On each item, only the materials necessary for that item were on the table. The other materials remained out of sight below the table. All responses were tape recorded.

Compensation. The compensation pretest consisted of four items. Each item began with the experimenter filling one of the 20 X 8.75-cm glasses approximately half full of seeds. One of the four nonidentical glasses then was introduced and placed beside the other glass. The new glass had a rubber band around it which the experimenter adjusted to the height of the seeds in the first glass. The experimenter than posed three randomly ordered questions: "If I poured the seeds in this glass over into this other glass, how high would they go? (a) Would they go higher than this line (pointing to the rubber band)? (b) Would they go right to this line? (c) Would they go below

this line?" The remaining three compensation items were the same, except that one of the other three nonidentical glasses was used on each item.

Training

In Curcio et al.'s experiment, the fiftieth percentile was used to partition pretest conservation performance into "conservation" and "nonconservation." The same value was used in this experiment. Subjects who made 0/12 - 6/12 correct judgments on the conservation pretests were classified as nonconservers and subjects who made 7/12 - 12/12 correct judgments were classified as conservers. Of the 118 children, 89 fell in the former category and 29 fell in the latter. A total of 80 of the 89 nonconservers were selected at random to participate in the training phase of the experiment. The only restriction on the selection was that the sample be equally divided with respect to sex.

The 80 children selected for the training portion of the experiment were randomly assigned to two groups: experimental and control. The only restriction on this assignment was that each group consist of 20 boys and 20 girls.

The training trials took place one week after the pretests. The training procedure has been described in detail elsewhere (Brainerd, 1972a, 1972b, 1974b) and, hence, will be only briefly summarized here. Both the experimental and control groups received eight training trials. Each training trial was a verbatim repetition of one of the four pretest conservation items. During the course of the training trials, each pretest item was repeated twice. The order in which the items were presented was random for all subjects. The only difference between the experimental and control training trials was that the experimenter said "You're wrong, that is not the correct answer" following each incorrect judgment and said "You're right, that is the correct answer" following each correct judgment during the administration of the experimental group's

items. During the control groups items, the experimenter said nothing following the subjects' judgments.

Posttests

As was the case in Curcio et al.'s experiment, conservation posttests were administered immediately after training and one week later. The immediate posttests consisted of three different tests of four items each. One test was simply a verbatim repetition of the conservation pretest. The remaining two were generalization tests. One of them was for liquid quantity conservation. The four items of this posttest were the same as the four items of the conservation pretest, except that the colored water was used in place of the seeds and the three conservation questions were concerned with the amount of water to drink rather than the amount of seeds to eat. The remaining posttest was for solid quantity conservation. The four pairs of colored clay balls were employed on items of this posttest. Each item began with a pair of balls placed side by side. After the subject agreed that both balls contained the same amount of clay, the experimenter performed one of two transformations: one of the pair members was rolled into a "sausage" or into a "pancake." Each transformation was repeated once. The three questions posed after each transformation were: (a) Do the ball and the sausage (pancake) have the same amount of clay? (b) Does one of them have more clay than the other? (c) Does one of them have less clay than the other? The posttests administered one week after training were the same as the immediate posttests.

Results

Insert Table 1 about here

The principal quantitative findings from the experiment appear by condition, time of test, and type of test in Table 1. A preliminary analysis revealed no sex differences on either pretest (N = 118 for both comparisons). Similarly, no sex differences were observed for either condition on any of the six posttests (N = 80 for all 12 comparisons).

To evaluate the order of emergence of compensation and conservation, the mean pretest composition and conservation scores were compared. The protocols of all 118 subjects to whom the pretests were administered were analyzed. The subjects' grasp of compensation proved to be much better than their grasp of conservation (correlated $t = 3.99$, $df = 117$, $p < .0001$). This replicates Curcio et al.'s finding that more children passed the compensation test than the conservation test. The significance tests reported in the remainder of this section involve only the protocols of the 80 subjects selected for training.

To determine whether or not the present feedback method was an effective conservation training procedure, the mean posttest scores of the experimental and control subjects were compared. On the immediate posttests, the superiority of the experimental subjects was pronounced on all three tests: discontinuous quantity ($t = 4.73$, $df = 78$, $p < .0001$); liquid quantity ($t = 4.62$, $df = 78$, $p < .0001$); solid quantity ($t = 4.97$, $df = 78$, $p < .0001$). On the delayed posttest, the superiority of the experimental subjects was equally apparent: discontinuous quantity ($t = 4.95$, $df = 78$, $p < .0001$); liquid quantity ($t = 4.36$, $df = 78$, $p < .0001$); solid quantity ($t = 4.11$, $df = 78$, $p < .0001$). Thus, the present feedback method proved to be an effective method for increasing performance on conservation tasks. This replicates the findings of other recent

studies in which the procedure has been employed (Ahr & Youniss, 1970; Brainerd, 1972a, 1972b, 1974b; Bucher & Schneider, 1973; Overbeck & Schwartz, 1970). To determined whether or not their was any "loss" across the one-week interval between the two sets of posttests, the immediate and delayed performances of the 40 experimental subjects on each of the three tests were compared. None of these comparisons proved significant: discontinuous quantity (correlated t = 0.95, df = 39, $p < .20$); liquid quantity (correlated t = 1.11, df = 39, $p < .20$; solid quantity (correlated t = 0.74, df = 39, $p < .30$).

To determine whether or not the present experimental subjects' understanding of compensation increased their susceptibility to conservation training, the overall and partial correlations among three dependent variables were computed for the 40 experimental subjects. The dependent variables were: (a) pretest compensation performance; (b) pretest conservation performance; (c) posttest conservation performance. Concerning variable c, it was observed that discontinuous, liquid, and solid quantity performance were highly correlated on both the immediate posttest (average multiple R = .79) and the delayed posttest (average multiple R = .71). Hence, for each set of posttests, variable c consisted of the pooled scores for the three tests.

Insert Table 2 about here

From the standpoint of Curcio et al.'s conclusion that compensation knowledge contributes to trainability, the critical values in Table 2 are the four which relate variables a and c. When we consider only the two overall correlations (in which the effects of conservation pretest performance are not partialed

out), there appears to be support for Curcio et al.'s conclusion. In both cases, there is a moderate positive correlation between the two variables. However, when we turn to the two remaining correlations, in which the effects of conservation pretest performance have been partialed out, the support vanishes. In both cases, the relation between the two variables does not depart significantly from zero. Thus, in so far as the present experimental group is concerned, prior knowledge of compensation does not predict relative trainability.

Discussion

Of course, it would be logically inappropriate to argue that the present findings conclusively disprove Curcio et al.'s conclusion and even more inappropriate to argue that the null hypothesis of "no relationship" is now more probable than before. However, it is fair to say that the preceding results provide no support for the claim that compensation knowledge increases conservation training susceptibility. Further, the present findings provide more than a simple failure to replicate. A reasonable alternative explanation for the particular datum that led Curcio et al. to conclude that compensation and trainability are related is implicit in the design of this experiment.

It also should be noted that the preceding results are consistent with both Curcio et al. and Piaget to the extent that they indicate that children grasp compensation before they grasp conservation--at least in the quantity concept area. However, the close <u>functional</u> connection between the two entailed by Piaget's analysis of the conceptual skills underlying conservation failed to appear. In this latter sense, the present findings resemble those reported by Gelman and Weinberg (1972) and Larsen and Flavell (1970).

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Table 1

Mean Numbers of Correct Judgments by Condition, Type of Test, and Time of Test

	Pretest		Posttest 1			Posttest 2		
	Conservation	Compensation	Discontinuous	Liquid	Solid	Discontinuous	Liquid	Solid
Experimental	2.48	7.88	9.25	9.05	8.98	8.98	8.67	8.75
Control	2.63	8.10	2.88	2.73	3.08	2.97	2.85	3.18

Note.--N = 40 for all cells

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Table 2

Overall and Partial Correlations between Pretest Conservation, Pretest Compensation and Posttest Conservation

Variable	Overall correlations			Partial Correlations		
	Pretest conservation	Pretest compensation	Postest conservation	Pretest conservation	Pretest compensation	Posttest conservation
Posttest 1						
Pretest conservation	...	.51****	.40**	...	.42***	.33*
Pretest compensation		...	.34*		...	.15
Posttest conservation			...			...
Posttest 2						
Pretest conservation	...	.51****	.47***	...	.42***	.38**
Pretest compensation		...	.32*		...	.09
Posttest conservation			...			...

Note.--N = 40 for all cells

*p<.025
**p<.01
***p<.005
****p<.0005